



Effect of maghemization on the magnetic properties of pseudo-single-domain magnetite particles

Almeida, Trevor; Muxworthy, Adrian; Kasama, Takeshi; Williams, Wyn; Damsgaard, Christian Danvad; Frandsen, Cathrine; Pennycook, Timothy; Dunin-Borkowski, Rafal

Publication date:
2015

Document Version
Publisher's PDF, also known as Version of record

[Link back to DTU Orbit](#)

Citation (APA):
Almeida, T., Muxworthy, A., Kasama, T., Williams, W., Damsgaard, C. D., Frandsen, C., Pennycook, T., & Dunin-Borkowski, R. (2015). *Effect of maghemization on the magnetic properties of pseudo-single-domain magnetite particles*. Abstract from 2015 AGU Fall Meeting, San Francisco, United States.
<https://agu.confex.com/agu/fm15/meetingapp.cgi/Paper/64475>

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

FALL MEETING

San Francisco | 14 – 18 December 2015

GP43A-1230: Effect of maghemization on the magnetic properties of pseudo-single-domain magnetite particles

ABSTRACT



Thursday, 17 December 2015

13:40 - 18:00

Moscone South - Poster Hall

During formation, magnetic minerals record the direction and intensity of the Earth's magnetic field. Paleomagnetists use this information to investigate, for example, past tectonic plate motion and geodynamo evolution. However, subsequent to formation the constituent magnetic minerals are commonly exposed to a range of weathering conditions and environments. One of the most common weathering processes is maghemization, which is the oxidation of magnetite (Fe_3O_4) at ambient temperatures, i.e., the slow oxidation of Fe_3O_4 to maghemite ($\gamma\text{-Fe}_2\text{O}_3$), and is known to alter the original remanent magnetization.

Of the constituent magnetic minerals, particles in the single domain (SD) grain size range (< 100 nm) are regarded as ideal paleomagnetic recorders because of their strong remanence and high magnetic stability, with potential relaxation times greater than that of the age of the Universe. However, magnetic signals from rocks are often dominated by small grains with non-uniform magnetization that exhibit magnetic recording fidelities similar to those of SD grains (termed pseudo-SD (PSD)).

In this context, the effect of maghemization on the magnetic properties of Fe_3O_4 grains in the PSD size range is investigated as a function of annealing temperature. X-ray diffraction and transmission electron microscopy confirms the precursor grains as Fe_3O_4 ranging from ~ 150 nm to ~ 250 nm in diameter, whilst Mössbauer spectrometry suggests the grains are initially near-stoichiometric. The Fe_3O_4 grains are heated to increasing reaction temperatures of $120 - 220$ °C to investigate their oxidation to $\gamma\text{-Fe}_2\text{O}_3$. High-angle annular dark field imaging and localized electron energy-loss spectroscopy reveals slightly oxidized Fe_3O_4 grains, heated to 140 °C, exhibit higher oxygen content at the surface. Off-axis electron holography allows for construction of magnetic induction maps of individual Fe_3O_4 and $\gamma\text{-Fe}_2\text{O}_3$ grains, revealing their PSD (vortex) nature, which is supported by magnetic hysteresis measurements, including first-order reversal curve analysis. The coercivity of the grains is shown to increase with reaction temperature up to 180 °C, but subsequently decreases after heating above 200 °C; this magnetic behavior is attributed to the growth of a $\gamma\text{-Fe}_2\text{O}_3$ shell

with magnetic properties distinct from the Fe_3O_4 core.

Authors

[Trevor Almeida](#)

Imperial College London

[Adrian Muxworthy](#)

Imperial College London

[Takeshi Kasama](#)

Technical University of Denmark

[Wyn Williams](#)

University of Edinburgh

[Christian Damsgaard](#)

Technical University of Denmark

[Cathrine Frandsen](#)

Technical University of Denmark

[Timothy Pennycook](#)

University of Vienna

[Rafal Dunin-Borkowski](#)

Forschungszentrum Julich GmbH

View Related Events

Session: [Fundamental Mineral and Rock Magnetism I Posters](#)

Section/Focus Group: [Geomagnetism and Paleomagnetism](#)

Day: [Thursday, 17 December 2015](#)

